A-5-9 LN

EVALUATION OF NEW NEGATIVE PHOTORESIST, LMR-UV, BY G-LINE WAFER STEPPERS

Y. YAMASHITA, R. KAWAZU, T. ITOH, K. KAWAMURA, S. OHNO, T. ASANO*, K. KOBAYASHI*, AND G. NAGAMATSU*

Research Laboratory, Oki Electric Industry Co., Ltd.
550-5 Higashiasakawa-cho, Hachioji-shi, Tokyo 193
*Fuji Chemicals Industrial Co.,Ltd.
3-12 Azabudai, 1-chome, Minato-ku, Tokyo 106

Near UV lithography by wafer steppers has become predominant in the production of VLSI and related devices. This technique achieves the theoretical resolution limit into the submicron range. However, the practical resolution limit has been considerably large due to difficulties in maintaining a constant resist linewidth over substrate topography. In order to gain practical resolution of 1 um or less with single-layer resist systems, it must be required to develop a new type of resist whose patterning will not be affected by reflection from the substrate.

On the basis of these considerations, we have developed a new negative photoresist, LMR-UV (Low molecular weight resist for near UV lithography). This paper deals with its patterning characteristics by g-line (435.8 nm) wafer steppers and its dry etching resistivity.

LMR-UV is a naphthoqunone-diazide sulfonic acid ester of a novolak resin whose polymerization degree is 10 or less. It has fairly strong absorption in the near UV region. Its absorption cofficient at g-lne is 2.0 um^{-1} and it is much larger than that of ordinary diazo-type positive photoresists (e.g. OFPR-800 ; 0.4 um^{-1} at g-line). Exposure was carried out on 1/5 reduction wafer steppers at g-line. The LMR-UV developer is a mixture of organic solvents.

Fig. 1 shows sensitivity curves for LMR-UV. The slope of the curve became steeper with an increse in developing time and γ value reached up to 3 at the developing time of 120 sec. On the other hand, the sensitivity, the minimum dose giving saturation in resist film thickness, was 100 mJ/cm2 and independent of developing time. Fig. 2 shows LMR-UV profiles formed by a g-line wafer stepper (NA=0.32). 0.6, and 0.7 um L/S patterns were clearly obtained. When the pattern width was 0.7 um or larger, LMR-UV formed rectangler profiles, which are suitable for anisotropic etching. Fig. 3 shows LMR-UV profiles formed on an Al substrate. 1.5 um-thick patterns submicron wide were reliably obtained. It was unnecessary to change the amount of dose when the resist was patterned on both Si and Al. Fig. 4 shows step coverage of LMR-UV. Steps were prepared by etching Si substrate 0.75 um in depth and depositing Al on it. No variation in pattern width due to steps is recognized. These phenomena are considered due to the fact that LMR-UV is hardly affected by reflection from the substrate because of its fairly strong absorption at g-line.

Etching resistivity of LMR-UV was evaluated using CCl4-RIE. AZ-1350J and PMMA were used as references. The etching rates of LMR-UV, AZ-1350J and PMMA were 100, 100 and 400 nm/min, respectively. In the case of dry etching, another requirement for resists is thermal stability. The profiles of LMR-UV was not changed when baked at 150°C for 30 min. In other words, LMR-UV has both high RIE resistivity and high thermal stability.

It is concluded that LMR-UV is a hopeful condidate for 1 um or less processes with single-layer resist systems using conventional g-line wafer steppers.

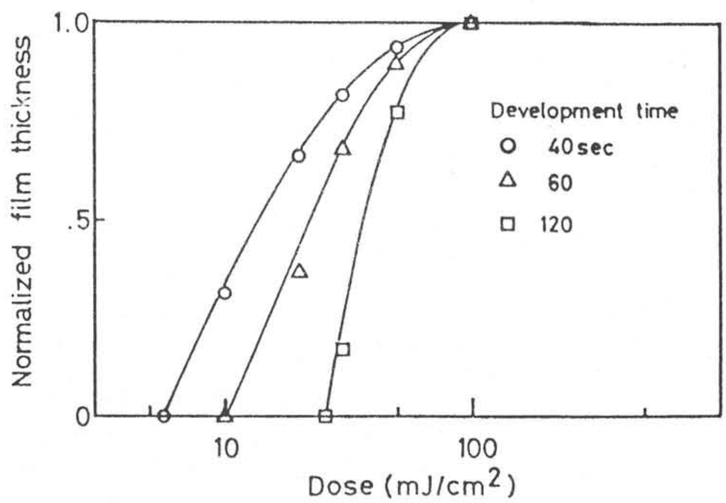

Fig. 1 Sensitivity curves for LMR-UV

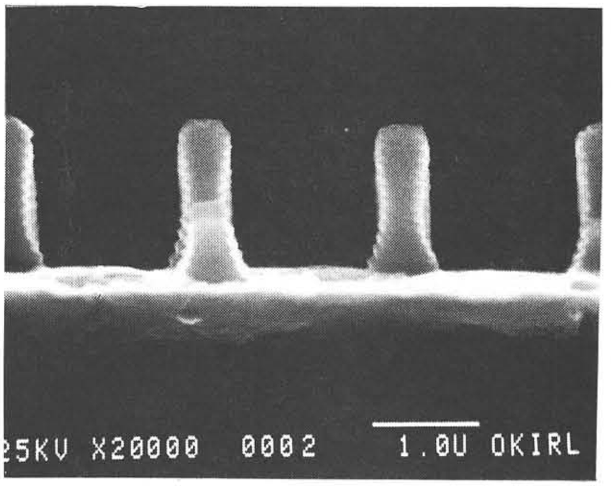

Fig. 3 LMR-UV profiles printed on Al by a g-line stepper

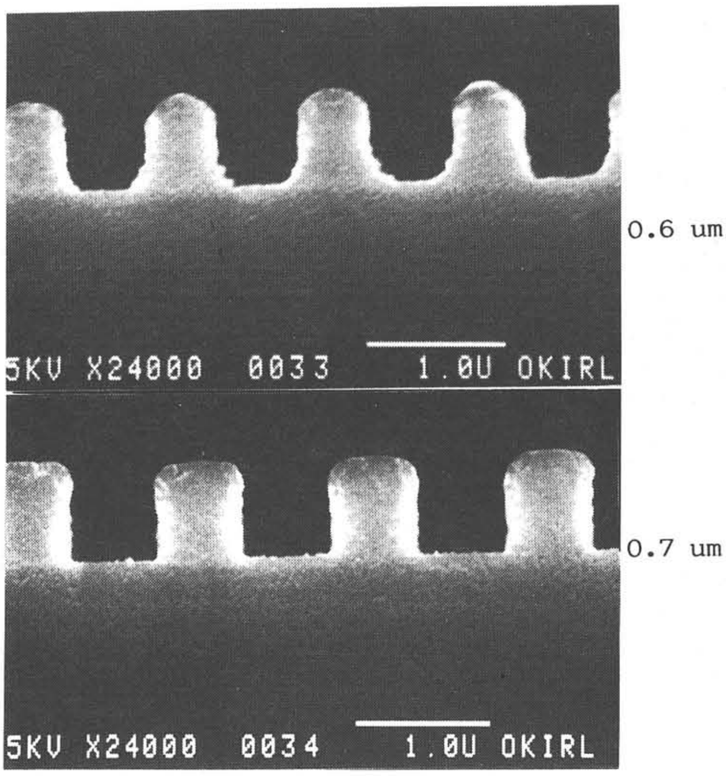

Fig. 2 LMR-UV profiles printed by a g-line stepper

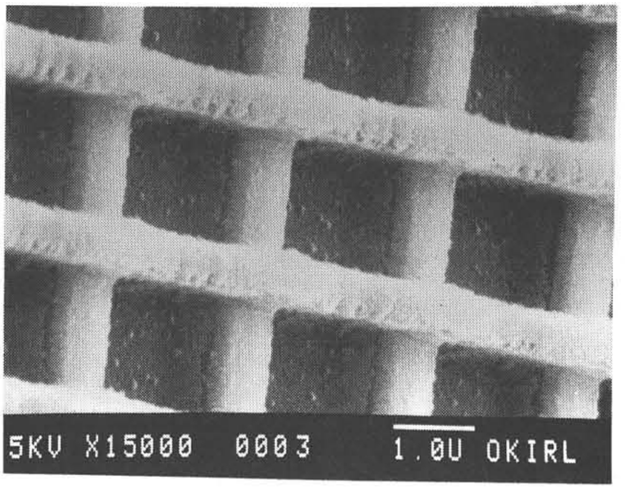

Fig. 4 LMR-UV patterns over 0.75-um-hight steps printed by a g-line stepper